



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUNDWATER, WATERSHED, AND ECOSYSTEM RESTORATION DIVISION
PO BOX 1198 • ADA, OK 74821

May 17, 2018

OFFICE OF
RESEARCH AND DEVELOPMENT

MEMORANDUM

SUBJECT: Final Pilot Study Implementation Work Plan for Operable Unit 2, Revised Groundwater Remedy, Site ST012, Former Williams Air Force Base, Mesa, Arizona (18-R09-005)

FROM: Eva L. Davis, PhD, Hydrologist

A handwritten signature in black ink, appearing to be "E. Davis", is written over the printed name.

TO: Carolyn d'Almeida, Remedial Project Manager, Region 9

I have reviewed the Final Pilot Study Implementation Work Plan for Operable Unit 2, Revised Groundwater Remedy for Site ST012 at the Former Williams Air Force Base, located in Mesa, Arizona. The work plan has undergone some revisions since it was first submitted as Draft Addendum #2 to the Remedial Design/Remedial Action Work Plan (RD/RAWP) in November 2015, however, many of the comments submitted on the original document and its revisions still have not been adequately addressed. Due to the fact that this version of the work plan is being implemented, my comments focus on the implementation plans that are presented. My comments are provided in detail below.

General Comments

1. The proposed approach for the pilot EBR is not consistent with recommended practices found in the research literature. In fact, the literature recommends against large influxes of sulfate concentrations, as proposed here, which can cause sulfide production, total dissolved solids (TDS) increases, and gypsum production, which have the potential to stress the microbial community, inhibiting microbial activity and/or the ability to continue injecting the sulfate (Suthersan, Houston, Schnobrich, and Horst, Engineered Anaerobic Bio-Oxidation Systems for Petroleum Hydrocarbon Residual Source Zones with Soluble Sulfate Application, Ground Water Monitoring & Remediation, 31(3):41-46, 2011). Suthersan et al. go on to say, "a reasonable level of control on sulfate dosing can help manage most of these potential complications . . . sulfate application strategies that employ repeat injections at highly elevated concentrations may not be as effective as sulfate delivery strategies that achieve relatively steady sulfate concentrations over time in the range of 100 to 2000 mg/L". ESTCP (Enhanced in situ Anaerobic Bioremediation of Fuel-Contaminated Ground Water, US Department of Defense,

CU-9522, 1999) states, "a practical limit for nitrate or sulfate introduction is around 80 mg/L. . . sulfate introduction is based on the fact that sulfate reduction can result in the accumulation of sulfide, which is inhibitory to many biodegradation processes." The proposed injections at 160,000 to 320,000 mg/L – two orders of magnitude greater concentration than recommended for optimal microbial growth – has the potential to make the groundwater quality worse without providing any significant benefit.

The ways in which these injections can make the situation worse includes: a) displacement of mobile LNAPL and dissolved phase contaminants into areas that were not previously impacted through the injection of very large quantities of sulfate-spiked water; b) introduction of sulfate into the subsurface at concentrations that exceed the Federal Drinking Water Guideline of 250 mg/L by as much as three orders of magnitude; c) by the introduction of a significant quantity of arsenic to the subsurface. Each of these is discussed in more detail below.

- a) Many of the planned injection/extraction well pairs call for extraction at the downgradient extent of the plume, allowing for LNAPL and dissolved phase contamination to be pushed downgradient. Examples of this are in injection/extraction well pairs CZ10/CZ07; CZ12, CZ03, & CZ16/CZ21; UWBZ10/UWBZ28; UWBZ12/UWBZ21; UWBZ16, 23, 29/UWBZ30; LSZ08 & LSZ17/LSZ51.
- b) Background concentrations of sulfate, which are generally around 300 mg/L, already exceed the Federal Drinking Water Guideline of 250 mg/L. Figures F-4 to F-9 clearly show sulfate concentrations 10,000 to 1,000 mg/L in excess of background concentrations leaving the contaminated area of the cobble zone (CZ) and migrating downgradient beginning within 120 days of the injections, and continuing for more than three years. About one year after injections, sulfate concentrations 1,000 to 10,000 mg/L in excess of background concentrations will begin migrating out of the contaminated zone in the UWBZ, and this will continue for far more than the six years for which model results are presented. In the LSZ, sulfate concentrations 1,000 mg/L in excess of background concentrations leave the contaminated area for more than six years after injection.
- c) Arsenic is an impurity in sodium sulfate. According to Section 3.3, certificates of analysis for the planned source of sodium sulfate showed non detect for arsenic in the past, with detection limits between 0.308 and 0.568 mg/kg. According to Amec's calculations in Appendix H, arsenic concentrations in the injectate are expected to range from 300 to 960 µg/L – approaching two orders of magnitude greater concentration than its Federal Drinking Water Maximum Contaminant Level (MCL) of 10 µg/L. The total mass of arsenic they expect to inject is enough to contaminate more than 60 million gallons of groundwater. Arsenic will clearly migrate downgradient from the treatment area along with the sulfate.

Despite the fact that the modeling performed clearly predicts that excessive sulfate concentrations will migrate off site, the re-circulation system that was included in the May 2014 RD/RAWP is not included in the Pilot Study Work Plan. Currently the monitoring plan in

Section 5 of the Pilot Study Work Plan calls for sampling the perimeter wells for VOCs, sulfate, and metals every three months. However, baseline data on these compounds is not being collected at all the perimeter wells, and there are no firm criteria in the Decision Matrix on threshold concentrations or concentration increases that would trigger implementation of recirculation when contaminants begin to show up at the perimeter wells. In the case of the CZ, the downgradient migration of sulfate (and thus arsenic) is expected to occur so rapidly that recirculation should be included at startup of injections into the CZ. Also, the extracted water treatment system should include arsenic removal so that arsenic is not re-injected into the aquifer.

2. The June 2016 baseline data shows that sulfate is not depleted in many areas of the jet fuel contaminated aquifer. This is especially true in the CZ, where sulfate concentrations range from 130 to 320 mg/l, in wells with benzene concentrations of 87 to 1200 ug/l, indicating the lack of sulfate consumption is not due to a lack of carbon substrate. ESTCP (1999) states, "Benzene, the most toxic of the BTEX compounds, has not been conclusively shown to degrade under all anaerobic conditions that exist in the field." Degradation that is not already occurring cannot be enhanced by the addition of large quantities of sulfate. Currently there is no data to demonstrate that sulfate degradation is occurring in the CZ.

3. Section 3.2.2 states, "test results (EBR monitoring data) including ongoing collection of LNAPL from completed wells would be used to evaluate if additional wells are needed to further characterize the limits of LNAPL". What monitoring results will trigger additional characterization activities? Please explain how it is believed that EBR can potentially be completed to return the aquifer to drinking water standards without defining the extent of LNAPL, and thus without addressing the full extent of LNAPL.

Specific Comments

4. Section 3.3 on page 3-7 states, "Individual areas of well influence were determined using Theissen polygons fitted to the injection locations . . .". However, the groundwater modeling results in Appendix F clearly indicate that water injected into SVE04 will not flow to extraction well CZ18; injections into CZ10, CZ11, and CZ12 will not flow to extraction well CZ21; injection into UWBZ32 will not flow to extraction well UWBZ22; injection into LSZ44 and W34 will not flow to extraction well LSZ29; injection into LSZ45, LSZ46, and W37 will not flow to extraction well LSZ12, as shown in the figures on slides 23, 24, and 25, respectively, of the April 17, 2018 BCT meeting.

5. Section 3.3 on page 3-8 states, "Baseline sampling conducted in July 2016 detected arsenic concentrations up to 110 µg/L although arsenic was not detected at most perimeter location. . . . There is no indication arsenic is migrating downgradient." These statements are misleading for more than one reason. First, according to the 2016 baseline sampling results contained in the Soil Vapor Extraction/Steam Enhanced Extraction System Operation and Maintenance Third Quarter 2016 Performance Report, four wells had arsenic concentrations greater than 110 µg/L: UWBZ30 and LSZ51 are both reported at 15 mg/L, UWBZ35 is reported at 7.3 mg/L, and

UWBZ29 is reported at 0.13 mg/L. Second, most of the downgradient sentry wells were not tested for arsenic, thus there is no way of knowing if arsenic is migrating offsite currently. What is obvious from the figures in Appendix F is that arsenic will migrate off site if injected into downgradient injection wells CZ10, CZ11, CZ12, UWBZ10, UWBZ12, UWBZ32, LSZ36, LSZ44, LSZ45, LSZ46, LSZ47, W34, and W37, as planned.

6. Figures 3-2, 3-3, and 3-4 show that the majority of the wells that are to be used as monitoring wells are not located properly to monitor EBR, as they are not located in between the injection and extraction wells.

7. Figure 3-4 shows that well W-34 is to be used for injection. By making well W34, which is currently a perimeter well, an injection well, there will then be no perimeter well in this vicinity to observe the downgradient migration. Either this well should not be used for injection or a downgradient perimeter well must be installed.

8. Section 4.2.6 discusses contingency planning, but makes no commitments to address the potential problems that may be encountered during the pilot scale EBR implementation. Instead of presenting a conditions that will trigger action to address problems that are identified by monitoring, the contingency plan only states actions that 'will be considered'. Monitoring data must be acted on to correct the observed problems in order for the monitoring to be useful. In consultation with the Agencies, threshold criteria should be established for each possible problem and remedies identified that will be triggered by threshold observations.

9. The groundwater head model results shown in Figures F-5, F-31, and F-51 do not represent groundwater heads or gradients provided in the Health, Safety, Environment and Remediation Site Operations Report for ST012.

10. Figures F-21 to F-30 clearly show that an area of known LNAPL contamination exists in the LSZ at SB-19, upgradient of the EBR treatment area. It is currently not known how far upgradient this source zone extends. Please explain how it is believed that EBR can potentially be completed without addressing all of the known LNAPL.

11. The Decision Matrix in Appendix J in the box, Target Criteria to Optimize Biological Degradation by SRB at ST012, presents average and maximum benzene concentration targets for each of the three vertical treatment zone that are based on the modeling contained in Appendix E of the RD/RAWP. Previous discussions on this model revealed that this was not a predictive model. These target concentrations cannot be relied on to trigger transitioning from EBR to MNA.

12. The Decision Matrix in Appendix J in the boxes, To Establish Biological Degradation by Sulfate Reducing Bacteria (SRB) at ST012 and has been Enhanced, Target Criteria to Optimize Biological Degradation by SRB at ST012, and Transition Criteria Achieved?, present average and maximum sulfate concentration targets of 2,000 – 10,000 mg/L and 30,000 mg/L,

respectively. These target concentrations far exceed the optimum range of 100 to 2000 mg/L presented by Suthersan et al. (2011). Please see comment #1.

If you would like to discuss any of these comments, I would be happy to do so. I can be reached at (580) 436-8548 or davis.eva@epa.gov.

cc: Anna-Marie Cook, Region 9
Richard Freitas, Region 9
Herb Levine, Region 9
ZiZi Searles, Region 9
David Bartenfelder, HQ
Linda Fiedler, HQ